STUDIES ON SOIL NEMATODES

DISSERTATION
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BY
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SUPERVISOR:

This is to certify that the entire research work presented in the dissertation entitled "Studies on soil nematodes" by Miss Mahlaqa Choudhary is original and was carried out under my supervision. I have allowed Miss Choudhary to submit it to the Aligarh Muslim University in fulfilment of the requirements for the Degree of Master of Philosophy in Zoology.

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INTRODUCTION

The soil-inhabiting nematodes are of four different types based on their mode of feeding, viz., free-living microphagous, saprophagous, phytophagous and predatory nematodes. For the present study nematodes of the first category and particularly those belonging to the suborder Alaimina Clark, 1961 were chosen. They are widely distributed, have small and slender bodies, and do not possess any defined feeding apparatus. So far they have been recorded from Germany, Italy, Japan, The Netherlands, New Zealand, Switzerland, U.S.A., USSR, Vietnam, India etc., but are sure to be cosmopolitan.

The Alaimid group of nematodes include at present the following genera - Alaimus, Amphidelus, Paramphidelus and Etamphidelus, the first three were already known from India, but Etamphidelus is being reported here for the first time. The genus Alaimus includes twenty nine species of which only seven are known to occur in India. Siddiqi and Husain (1967) for the first time reported six new species of Alaimus from India, viz., A. jaulasali, A. thrixus, A. leptus, A. medius, A. editorus, A. hamulus. Khera (1972) described A. multistriatus from Lucknow, India. Amphidelus novus Baqri & Jairajpuri, 1968 , P. sylvaticus and P. candidus (Siddiqi & Basir, 1965) Andrássy, 1977 are known from this country. So far, thirteen species of Amphidelus, twenty of Paramphidelus

and two of Etamphidelus have been described from different parts of the world.

The present work gives a brief account of the morphology and systematics of Alaimid nematodes. It also includes the description of ten species of Alaimids, four species belong to Alaimus of which one is known and three are new, two known species belong to Paramphidelus and one known and three new to Etamphidelus. All the nematode species have been described in detail and their diagnostic characters and illustrations have been provided.

MATERIAL AND METHODS

Collection of soil samples: The soil samples were collected from different localities mostly from the hills of Uttar Pradesh, Himachal Pradesh and North Eastern states of India. The soil was collected from a depth of 10-30 cm and the samples were stored in polythene bags until processing.

Processing of soil samples: The soil samples were processed by Cobb's (1918) modified sieving and decantation technique. About 500 gms of soil was put in a bucket filled two-thirds of its volume with water. The water was stirred gently and the soil was brought to a homogeneous suspension. It was then left undisturbed for a few minutes. The entire suspension was passed first through a coarse sieve and then through a sieve of mesh no. 300. The suspension collected as above was placed in a modified Baermann funnel. After twenty four hours the nematodes were collected from the bottom tubing attached with the funnel.

Killing and fixation: The nematodes were killed and fixed in hot (60-70°C) 8% formaldehyde (double strength). The nematodes killed as above were stored in the same medium.

Mounting and sealing: The Alaimid nematodes were picked up with the help of a sharp bamboo needle and were transferred to a cavity block containing a mixture of glycerine alcohol (5 part glycerine + 95 parts 30% alcohol) and then kept in a desiccator at room temperature for about 2-3 weeks. Dehydrated nematodes were mounted in anhydrous glycerine on glass or aluminium slides.

A drop of glycerine was placed on the slide and the nematodes were transferred one by one from the cavity block to this drop on the slide. Pieces of glass wool of suitable thickness were put on the sides of the nematodes and then a coverslip was placed over it. The edges of the coverslip were sealed with either 'glyceel', 'nail-polish' or with the sealing material made from 'putty'.

Measurements and drawings: An ocular micrometer was used for taking measurements. The drawings were prepared with the help of camera lucida. In the text lum stands for µm.

MORPHOLOGY OF ALAIMIDS

The Alaimids may be immediately recognised in a mixed nematode suspension because of their slender bodies. Their body length varies from 0.5 - 4.0 mm, and the feeding apparatus is absent. Also upon fixation they assume a ventrally arcuate posture.

Cuticle: The cuticle is about 1µm thick on entire body and is marked by very fine transverse striations which may sometimes be invisible (*Alaimus leptus*). In some species longitudinal striae may also be present (*Alaimus striatus* and *Alaimus multistriatus*).

Lip region: The lip region is usually rounded and continuous with the body. Only in *Alaimus thrixus* it is conoid. There are six lips of equal size each with a papilla on the inner and outer margins.

Amphids: The amphids and their apertures are of great taxonomic value in Alaimids. They show interesting variations in size and location. The amphidial openings exhibit different shapes. In *Alaimus* the amphidial apertures are minute, pore-like, amphidial pouches are absent and the sensillae are closed to the amphidial apertures. In *Amphidelus*, *Paramphidelus* and *Etamphidelus* the amphidial pouches are large and the sensillae are placed far from amphidial apertures.

In Amphidelus the amphids are calyciform in shape and are situated quite close to the cephalic end. In Paramphidelus they are funnel-shaped or tennis-racket-shaped and are placed far from the cephalic end. In Etamphidelus they are large and oval in shape (cf. Andrassy, 1977).

Stoma and Oesophagus: The stoma is highly reduced in all members of family Alaimidae. It may appear to be conical, triangular, and is unarmed as these nematodes are non-parasitic and usually feed on microorganism etc. The oesophagus consists of an anterior slender non-muscular part and a swollen glandular portion. The glandular part has 5-7 oesophageal glands all of which open into the lumen of the oesophagus.

Cardia: Cardia is small, conoid to rounded in Alaimus thrixus, conoid in Alaimus hamulus. In species of Amphidelus the cardia is generally small and disc-like.

Intestine and Rectum: Intestine is a straight tube composed of a single layer of epithelial cells. Prerectum is completely absent and the intestine terminates directly into a short rectum which is dorso-ventrally flattened.

Female reproductive organs:

The female reproductive organs are either mono-prodelphic (Etamphidelus, Amphidelus, Paramphidelus), mono-opisthodelphic or

amphidelphic (Amphidelus, Alaimus, Paramphidelus). Each sexual branch consists of an ovary, oviduct, uterus, vagina and vulva.

Ovary: Ovary may be reflexed dorsally or ventrally and consists of a distal germinal zone and a proximal growth zone. The germinal zone bears small cells confined to the apical part of the ovary where the proliferation of the germinal cells takes place (telogony) The growth zone has cells or oocytes which are arranged in a single row increasing in size proximally.

Oviduct: The ovary joins the oviduct which is a narrow tube having high columnar epithelial cells.

Uterus: The uterus is a broad tube irregular in outline and lined with flat cuboidal epithelium. The beginning of the uterus usually functions for sperm storage. The fertilization may also take place in this region. Sometimes the distinction between the oviduct and uterus may not be discernible.

Vagina: The uterus or the uteri join a muscular tube called the vagina. It is lined with cuticle and provided with a sphincter. The length of the vagina may vary. It may be straight or directed anteriorly or posteriorly depending on the type of the reproductive system.

Vulva: It is a transverse slit formed by the invagination of the body cuticle and is controlled by two sets of muscles - the constrictor and the dilatator vulvae. The species of Etamphidelus are characterised by strongly developed vulval muscles (cf. Andrássy, 1977).

Male Reproductive organs:

The male reproductive system is mono-orchic. It consists of a testis, vas deferens, and cloaca. The testis is outstretched and telogonic. The proximal part is germinal while the distal is the growth zone. The sperm mature in the distal part. The testis opens into the vas deferens which is long and tubular. The cloaca is lined with cuticle and opens to the exterior through the cloacal aperture.

Besides the primary sex organs the males also posses accessory structures. These are spicules and the ventromedian supplements.

Spicules: The spicules are paired and similar in size and shape. They are knobbed distally as in Alaimus primitivus or cephalated as in Alaimus hamulus. Etamphidelus japonicus has dorylaimoid type of spicules. The length of spicules varies from 8 um (Alaimus thrixus, P. sylvaticus) to 15 um (E. japonicus). The spicules are guided by a set of protractor and retractor muscles.

Supplements: The supplements consist of a few ventromedians which are spaced irregularly. These may vary from two (E. japonicus) to seven ([redacted] sp.). The adanal pair of supplements are absent.

Tail: Tails are similar in the two sexes. The shape and size may vary within the different species of a genus. It may vary from conoid to long filiform. It is conoid (Amphidelus boa), elongate-conoid (Alaimus thrixus), ventrally hooked (Alaimus hamulus), mucronate (Alaimus mucronatus), rounded (Alaimus medius), filiform (P. macer, P. dolichurus, P. palustris).

SYSTEMATICS OF ALAIMIDS

De Man (1880) proposed the genus Alaimus for nematodes having long and slender bodies, minute amphidial apertures, and dorylaimoid type of oesophagus. Micoletzky (1922) proposed the family Alaimidae. Thorne (1939) considered this family under Dorylaimoidea (De Man, 1876) Thorne, 1934. Chitwood and Chitwood (1937) placed it under the order Enoplida. Later, a new suborder Alaimina was proposed by Clark (1961) which was placed under Enoplida on the basis of seven oesophageal glands and the opening of dorsal oesophageal gland posterior to nerve ring (Chitwood, 1937). This concept of Alaimina was then modified by Clark (1962) by bringing superfamily Diphtherophoroidea (Micoletzky, 1922) Clark, 1961 under it. Goodey (1963) also considered the Alaimids under Dorylaimida (De Man, 1876) Pearse, 1942.

Siddiqi and Husain (1967) did not accept the transfer of Diphtherophoroidea to the rank of a suborder. Later, Khera (1972) placed the superfamily Diphtherophoridea as a connection between Dorylaimina and Alaimina and also agreed with Goodey (1963) in placing suborder Alaimina as well as Dorylaimina under the order Dorylaimida as the characters of these two suborders and of Diphtherophorina (Thorne, 1935) Khera, 1972 are covered by the definition of order Dorylaimida.

Andrássy (1976) did not recognize the suborder Alaimina under the order Dorylaimida but suppressed it to familial rank and placed it in the superfamily Oxystominoidea Filipjev, 1918 under the order Enoplida. Maggenti (1976) included the two suborders Dorylaimina and Alaimina under Dorylaimida.

In the present study the author has preferred to place the Alaimid nematodes under the order Dorylaimida mainly because of the typical dorylaimoid oesophagus, five to seven oesophageal glands, and the absence of caudal glands. The diagnoses of various taxonomic groups under Alaimina is provided below.

SUBORDER ALAIMINA CLARK, 1961

Diagnosis: Body slender, stoma unarmed and highly reduced. Amphidial apertures either pore-like or elliptical. Oesophagus typically dorylaimoid, gradually widening to a posterior pyriform bulb with five to seven oesophageal glands. Excretory system rudimentary, excretory pore may be present. Female reproductive system mono-prodelphic, mono-opisthodelphic or amphidelphic. Testis single, ejaculatory duct not differentiated. Spicules paired, similar, arcuate or straight, often cephalated. Gubernaculum absent. Ventromedian supplements present.

Type and only superfamily: Alaimoidea (Micoletzky, 1922) Goodey, 196

SUPERFAMILY ALAIMOIDEA(MICOLETZKY, 1922)GOODEY, 1963

Diagnosis: Stoma highly reduced and unarmed. Amphidial apertures minute or crescentic-slit like, often placed far from lip region. Oesophagus dorylaimoid, expanded part having 5-7 oesophageal glands. Female reproductive system single or double. Spicules paired, straight or arcuate. Gubernaculum absent.

Type family: Alaimidae Micoletzky, 1922

Other family: Amphidelidae n. fam.

FAMILY ALAIMIDAE MICOLETZKY, 1922

Diagnosis: Lip region very narrow. Stoma vestigial, unarmed. Amphidial apertures minute pore like amphidial pouch absent, sensillae close to amphidial apertures. Oesophagus widening to a posterior pyriform bulb with 5 or 7 oesophageal glands. Exeretory pore present. Female reproductive system monodelphic or amphidelphic. Testis single, outstretched; spicules arcuate, dorylaimoid. Ventromedian supplements present.

Type and only genus: *Alaimus* de Man, 1880

FAMILY AMPHIDELIDAE N. FAM.

Diagnosis: Lip region as wide as corresponding body. Stoma vestigial unarmed. Amphids calyciform, tennis-racket shaped or

oval placed near or far away from the cephalic end. Basal expanded part of the oesophagus occupying about one-third of total oesophageal length. Female reproductive system monodelphic or amphidelphic. Testis single, outstretched; spicules straight or dorylaimoid. Ventromedian supplements spaced irregularly. Tail long filiform or elongate-conoid in both sexes.

Type genus: Amphidelus Thorne, 1939

Other genera: Paramphidelus Andrassy, 1977

Etamphidelus Andrassy, 1977

Relationship: The new family Amphidelidae comes close to family Alaimidae Micoletzky, 1922 but differs from it in having a wider lip region, amphids having slit-like or oval apertures and well developed amphidial pouches.

GENUS ALAIMUS DE MAN, 1880

Diagnosis: Lip region rounded, continuous, with body contour Cephalic papillae in two circles, outer ones easily visible inners obscure. Stoma small and triradiate. Excretory pore variable in position. Amphidial apertures minute, amphidial pouches absent, sensillae close to amphidial apertures. Oesophagus narrow in anterior two-thirds but expanding in posterior-third to

a basal bulb bearing seven oesophageal glands. Cardia small, discoidal or conoid. Vulva transverse. Female reproductive system monodelphic or amphidelphic. Ventromedian supplements present.

Type species: Alaimus primitivus de Man, 1880

Other species: A. aculeatus Andrássy, 1968,
A. acutus Thorne, 1939
A. andrassyi Saboá, 1967
A. arcuatus Thorne, 1939
A. depressus Loof, 1971
A. editorus Siddiqi & Husain, 1967
A. elongatus de Man, 1906
A. glissus Thorne, 1939
A. hamulus Siddiqi & Husain, 1967
A. himatangiensis Yeates, 1967
A. jaulasali Siddiqi & Husain, 1967
A. leptus Siddiqi & Husain, 1967
A. macer Andrássy, 1958
A. medius Siddiqi & Husain, 1967
A. meyli Andrássy, 1961
A. minor Cobb, 1853
A. mucronatus Altherr, 1950
A. multistraitus Khera, 1972

A. parvus Thorne, 1939

A. proximus Thorne, 1939

A. robustus Andrássy, 1973

A. siddiqii Andrássy, 1970

A. similis Thorne, 1939

A. simplex Cobb, 1914

A. striatus Loof, 1964

A. thamugadi Maupas, 1900

A. tenuis Thorne, 1939

A. thrixus Siddiqi & Husain, 1967

Species inquirendae (after Siddiqi & Husain, 1967):

A. filiformis Daday, 1894

A. modestus Schuurmans Stekhoven and Teunissen, 1938

A. multipapillatus Wu and Hoeppli, 1929

A. papillatus (Daday, 1899) Micoletzky, 1922

ALAIMUS ACUTUS THORNE, 1939

(Fig. 1, A - E)

Dimensions:

Females (5): L = 0.6-0.7 mm; a = 34-39; b = 3.5-5.5; c = 7-12; c' = 6-7; V= 36-43.

Description:

Female: Body ventrally arcuate upon fixation. Lip region rounded continuous with body contour, one-third or one-fourth as wide as midbody. Stoma 1-2 um long. Amphidial apertures pore-like 48-58 um from anterior end of body. Oesophagus 135-186 um long, basal expanded part 18-21% of total oesophageal length. Nerve ring 80-96 um from anterior end of body. Cardia small, discoid, 2-3 um long.

Vulva transverse, vagina 3-4 um long, directed posteriorly. Female reproductive system mono-opisthodelphic. Rectum 9-11 um or about one anal body-width long. Tail elongate-conoid 51-68 um or 6-7 anal body-widths long.

Male: Not found.

Habitat and locality: Soil around roots of palm from Nalanda, Bihar.

Remarks: [redacted] acutus Thorne, 1939 is reported here for the first time from India. The present specimens conform well with the description and dimensions of the species as given by Thorne (1939) except in having a longer body and tail.

ALAIMUS ASSAMUS N.SP.

(Fig. 1, F - K)

Dimensions:

Paratype female: L = 0.9 mm; a = 44; b = 4.4; c = 13; c' = 7.1; V = 47.

Paratype males (3): L = 0.7-1.0 mm; a = 33-36; b = 2.8-4.4; c = 12-17; c' = 3-4; T = 62-64.

Holotype female: L = 1.0 mm; a = 47; b = 3.7; c = 13; c' = 7; V = 48.

Description:

Female: Body slightly ventrally arcuate upon fixation. Lip region rounded, continuous with body contour, 1/6-1/7th of midbody width. Stoma 2 um long. Amphidial apertures pore-like, 60-67 um from cephalic end. Oesophagus 225-255 um long, basal part occupying 25-35% of total oesophageal length. Nerve ring 120-130 um from anterior end of body. Cardia 3-4 um long, discoid.

Vulva transverse; vagina thick-walled, 6-7 um long. Female reproductive system mono-opisthodelphic. Rectum 7-8 um or less than one anal-width long. Tail conoid 75-76 um or about 7 anal body-widths long.

Male: Spicules slender, almost straight, 10-13 um or about one anal body-width long. Ventromedian supplements, three extending to a distance of 28-32 um from cloaca. Tail conoid 49-57 um or 3-4 anal body-widths long.

Type habitat and locality: Soil around roots of marigold, Tagetes erecta L., from Gauhati University Campus, Gauhati, Assam.

Type specimens: Collected in January 1978. Holotype female on slide MNP/Alaimus assamus n. sp./1; paratype on slides MNP/Alaimus assamus n. sp./2-3 deposited in the Zoology Department, Aligarh Muslim University, Aligarh.

Differential diagnosis: Alaimus assamus n. sp. comes close to A. proximus Thorne, 1939, A. tenuis Thorne, 1939 and A. similis Thorne, 1939. From the former it differs in having a smaller and wider body, longer oesophagus, longer tail and more posteriorly located vulva and three ventromedian supplements (L = 1.3 mm; a = 50; b = 5.9; c = 17; V = 42; 4-6 ventromedian supp. A. proximus

From A. tenuis it also differs in having a smaller and wider body, a longer tail, posteriorly located vulva and lesser number of ventromedian supplements. (L = 2.5 mm; a = 60; b = 7.7; c = 24; V = 48; 5-7 ventromedian supplements in A. tenuis).

Lastly, it differs from A. similis in having a smaller body, a longer oesophagus, a longer oesophageal bulb, posteriorly located vulva and a longer tail (L = 1.3 mm; b = 5.0; oesophagus with a small conoid bulb; V = 36; c = 14).

ALAIMUS PRIHAMUS N. SP.

(Fig. 2, A-F)

Dimensions:

Paratype females (8) L= 0.9-1.1 mm; a = 42-62; b = 4.1-5.5; c = 8-9; c' = 10-12; V = 38-45.

Paratype male: L = 0.7 mm; a = 41; b = 3.8; c = 11; c' = 5; T = 45.

Holotype female: L = 0.9 mm; a = 52; b = 4.6; c = 8; c' = 10 V = 38.

Descriptions:

Female: Body upon fixation slightly ventrally arcuate, more in posterior region. Lip region rounded, continuous with bo contour, 1/4-1/3rd of midbody. Stoma 1-2 um long. Amphidial apertures pore-like, 28-31 um from anterior end. Oesophagus 202-241 um long, basal part occupying 16-22% of total oesophageal length. Nerve ring at 88-120 um from anterior end of body. Cardi discoid, 3 um long.

Vulva transverse; vagina 2-3 um long, directed posteriad. Female reproductive system mono-opisthodelphic, ovary reflexed. Rectum 9-12 um or almost one anal body-width long. Tail elongate-conoid, 108-135 um or 11-12 anal body-widths long.

Male: Spicules slender, straight, 14 um or about one anal body-width long. Ventromedian supplements seven extending to a distance of 63 um from cloaca. Tail conoid, 67 um or about five anal body-widths long.

Type habitat and locality: Soil around roots of pineapple, Ananas comosus L., from Gauhati University Campus, Gauhati, Assam.

Type specimens: Collected in January 1978. Holotype female on slide MNP/Alaimus prihamus n.sp./1; paratypes on slide MNP/Alaimus prihamus n.sp./2-5; deposited in the Zoology Department, Aligarh Muslim University, Aligarh.

Differential diagnosis: Alaimus prihamus n. sp. comes close to A. hamulus Siddiqi & Husain, 1967, A. jaulasali Siddiqi & Husain, 1967 and A. primitivus de Man, 1880. From A. hamulus it differs in having a smaller oesophageal expanded part, a longer tail, anterior longer spicules and seven ventromedian supplements (c = 11-15; spicules = 10 um; ventromedian supplements five in A. hamulus).

From A. jaulasali it differs in having a longer body, smaller oesophageal expanded part, longer spicules, seven ventromedian supplements (L = 1.1-1.2 mm; spicules = 9 um; six ventromedian supplements in A. jaulasali).

It can be differentiated from A. primitivus in having a smaller body, shorter tail, longer spicules and greater number of ventromedian supplements (L = 1.2 mm; c = 5-7; in A. primitivus).

ALAIMUS HISTORICUS N. SP.

(Fig. 2, G - K)

Dimensions:

Paratype females (5) L = 0.5-0.6 mm; a = 25-33; b = 3.6-5.0; c = 15-22; c' = 3.9-4.8; V = 48-49.

Holotype female: L = 0.6 mm; a = 29; b = 5.0; c = 15; c' = 4.8; V = 42.

Descriptions:

Female: Body 'C' shaped upon fixation. Lip region rounded, continuous with body contour, 1/4-1/3rd of midbody width. Stoma 1-2 um long. Amphidial apertures pore-like, 44-45 um from anterior end. Oesophagus 111-165 um long, basal part occupying 20-27% of total oesophageal length. Nerve ring 85-90 um from anterior end of body. Cardia small, 1-2 um long.

Vulva transverse, vagina 3 um long. Female reproductive system mono-opisthodelplic. Rectum 6-8 um long, less than one anal body-width long. Tail conoid, 30-43 um long, 3-4 anal body-widths long.

Type habitat and locality: Soil around roots of lawn grass in front of Nalanda Museum, Bihar.

Type specimens: Collected in October, 1978. Holotype female on slide BR/Alaimus historicus n.sp./1; paratypes on slides BR/Alaimus historicus n.sp./2&3; deposited in the Zoology Department, Aligarh Muslim University, Aligarh.

Differential diagnosis: Alaimus historicus n. sp. comes close to A. editorus Siddiqi & Husain, 1967 and A. acutus Thorne, 1939. From A. editorus it differs in having a wider body and a smaller tail (a = 33-38; c = 10-13). It differs from A. acutus in having a smaller body, a smaller tail and a posteriorly located vulva (L = 0.8 mm; a = 36; c = 15; V = 43).

GENUS PARAMPHIDELUS ANDRASSY, 1977

Diagnosis: Body slender, 0.5-2.5 mm long. Lip region rounded or conical, offset. Amphids funnel-shaped or tennis-racket-shaped, far from cephalic end. Amphidial apertures large, semi-lunar, arcuating backwards. Oesophagus about 20% of total body length. Female reproductive system monodelphic or amphidelphic. Anterior uterine sac may be present. Vagina thin-walled, usually directed posteriad. Tail long, tapering to a fine rounded terminus. Spicules short and thick. Ventromedian supplements 2-4.

Type species: Paramphidelus dolichurus (de Man, 1876) Andrássy, 197

Other species: P. candidus (Siddiqi & Basir, 1965) Andrássy, 1977
P. effiliatus (Schuurmans Stekhoven, 1951) Andrássy, 197
P. exilis (Andrássy, 1962) Andrássy, 1977
P. hortensis (Andrássy, 1961) Andrássy, 1977
P. hyans (Thorne, 1939) Andrássy, 1977
P. lemani (Stefanski, 1914) Andrássy, 1977
P. macer Andrássy, 1977
P. monohystera (Heyns, 1962) Andrássy, 1977
P. palustris Andrássy, 1977
P. papuanus (Andrássy, 1973) Andrássy, 1977
P. paramonovi (Eliashili, 1971) Andrássy, 1977
P. propinquus (Andrássy, 1962) Andrássy, 1977
P. pseudobulbosus (Altherr, 1953) Andrássy, 1977

P. pusillus (Thorne, 1939) Andrássy, 1977

P. sylphus (Thorne, 1939) Andrássy, 1977

P. sylvaticus (Siddiqi & Basir, 1965) Andrássy, 1977

P. tasmaniensis (Allgen, 1929) Andrássy, 1977

P. trichurus (Siddiqi & Basir, 1965) Andrássy, 1977

P. uniformis (Thorne, 1939) Andrássy, 1977

PARAMPHIDELUS MACER ANDRÁSSY, 1977

(Fig. 3 A - F)

Dimensions:

Females (3): L = 1.0-1.3 mm; a = 81-88; b= 4.1-4.6; c = 16-18; c' = 7.5-8.3; V = 39-43.

Descriptions:

Female: Body long and slender, straight upon fixation. Lip region rounded, 5-6 um or more than half of midbody width wide. Stoma small, half of lip-width. Amphids funnel-shaped, 3 um wide, placed three-four head-widths from anterior end of body. Oesophagu 246-286 um long, basal part occupying 17-21% of total oesophageal length. Nerve ring at 130-157 um from anterior end of body. Cardia small, 2-3 um long.

Vulva transverse, vagina 7-8 um or about half of vulval body-width. Female reproductive system mono-opisthodelphic. Rectum 9-10 um or about one anal body-width long. Tail elongate-conoid, 67-75 um or 7-8 anal body-widths long, gradually tapering to a pointed terminus and is provided with a mucro.

Male: Not found.

Habitat and locality: Soil around roots of weeds and grasses (unidentified) from near Gulaba Army Camp, Manali, Himachal Pradesh.

PARAMPHIDELUS SYLVATICUS (SIDDIQI & BASIR, 1965) ANDRASSY, 1977

(Fig. 3, G - M)

Dimensions:

Females (4): L = 1.1-1.3 mm; a = 67-79; b = 4.6-5.7; c = 8; c' = 18-22; V = 37-41.

Male: L = 1.2 mm; a = 73; b = 4.9; c = 9; c' = 18; T = 48.

Descriptions:

Females: Body L-shaped upon fixation. Lip region rounded, continuous with body contour, 3-4 um wide or 1/5th as wide as midbody. Stoma one lip-width wide. Amphids cyathiform, 2-3 um wide at 3 lip-width from anterior end. Oesophagus 226-265 u

long, basal part occupying 25-30% of total oesophageal length. Nerve ring at 133-145 um from anterior end of body. Cardia flattened, 3-4 um long.

Vulva transverse, vagina 7-8 um or about one half of body-width long. Female reproductive system mono-opisthodelphic. Anterior uterine sac 33-45 um or about one vulval body-width long. Rectum 9-10 um or about one anal body-width long. Tail filiform, 135-164 um or about 15-18 anal body widths long.

Male: Spicules 9 um long, straight. Ventromedian supplements three, extending to a distance of 45 um from cloaca. Tail filiform, 135 um long.

Habitat and locality: Soil around roots of palm from Nalanda, Bihar.

GENUS ETAMPHIDELUS ANDRASSY, 1977

Diagnosis: Lip region rounded, papillae in a pit with cuticularized edges. Amphids oval and wide, laterally appear as deep pockets with cuticularized boundaries. Female reproductive system mono-prodelphic. Vulval muscles well developed. Vagina thin or thick-walled, straight. Spicules strong, dorylamoid, ventromedian supplements 2-5. Tail ventrally arcuate, terminus pointed.

Type species: E. japonicus Andrássy, 1977

E. puccinelliae (Lorenzen, 1966) Andrássy, 1977

E. andrássyi n. sp.

E. intermedius n. sp.

E. mucronatus n. sp.

ETAMPHIDELUS JAPONICUS ANDRÁSSY, 1977

(Fig. 4)

Dimensions:

Females (5): L = 0.9-1.1 mm; a = 75-82; b = 3.6-4.0; c = 10-12; c' = 10-17; V = 62-64.

Descriptions:

Female: Body almost C-shaped upon fixation, tapering towards both extremities. Lip region rounded, 3 um or 1/5-1/4th

of midbody width; papillae arranged in a pit. Stoma small, half of lip-width. Amphids 3um wide, and 2-3 lip-widths from anterior end of body, edges cuticularized. Oesophagus 255-310 um long, basal bulb occupying 25-29% of total oesophageal length. Nerve ring at 117-127 um from anterior end of body. Cardia small 4-5 um long.

Vulva transverse; vagina thick-walled, 7-9 um or about one vulval body-width long, inclined anteriad. Female reproductive system mono-prodelphic. Rectum 9-12 um or more than one anal body-width long. Tail elongate conoid, 90-117 um or 10-17 anal body-widths long. Vulva-anus distance 279-355 um or 2-3 times of tail length.

Male: Not found.

Habitat and locality: Soil around roots of tea plants Camellia sinensis L., from Maranda, Palampur, Himachal Pradesh.

ETAMPHIDELUS ANDRÁSSYI N. SP.

(Fig. 5)

Dimensions:

Paratype females (5): L = 0.9-1.2 mm; a = 65-78; b = 2.9-3.9; c = 7-9; c' = 18-24; V = 68-76.

Paratype males (6): L = 0.9-1.08 mm; a = 58-70; b = 3.5-4.1; c = 9-10; c' = 10-12; T = 45-56.

Holotype female: L = 1.1 mm; a = 67; b = 3.5; c = 6; c' = 21; V = 68.

Descriptions:

Female: Body slender, ventrally arcuate upon fixation, tapering slightly anteriorly but markedly towards tail. Lip region rounded 3-4 um or about 1/5 - 1/6th of midbody width. Stoma small, about half lip-width. Amphids about 2 um wide and oval, 3-4 head-widths from anterior end of body. Oesophagus 255-420 um long, basal part occupying 20-24% total oesophageal length. Nerve ring at 150-178 um from anterior end of body. Cardia 3-4 um long.

Vulva transverse; vagina 6-7 um long, inclined anteriorly. Female reproductive system mono-prodelphic. Rectum 11-12 um or about one and half anal body-widthslong. Tail long filiform, 135-192 um or 15-24 anal body-widths long.

Male: Spicules 10-11 um long, arcuate. Ventromedian supplements three extending to a distance of 53-59 um from cloaca. Tail 105-135 um or 10-12 anal body-widths long.

Type habitat and locality: Soil around roots of an unidentified flowering plant, Chingmairong South hill, district Imphal, Manipur.

Type specimens: Collected in August, 1977. Holotype on slide MNP/Etamphidelus andrassyi n. sp./1; paratypes on slide MNP/ Etamphidelus andrassyi n. sp./2-5; deposited in the Zoology Department, Aligarh Muslim University, Aligarh.

Differential diagnosis: Etamphidelus andrassyi n. sp. comes close to E. japonicus but differs in having a smaller body, posteriorly located vulva, longer tail, ventromedian supplements three and smaller spicules (L = 1.14-1.16 mm; V = 65-66; c = 36-3[illegible] ventromedian supplements two and spicules 15 um in E. japonicus.)

ETAMPHIDELUS INTERMEDIUS N. SP.

(Fig. 6)

Dimensions:

Paratype females (2) L = 0.9-1.0 mm; a = 42-50; b = 3.2-3.8 c = 7-8; c' = 13; V = 61-64.

Holotype female L = 1.2 mm; a = 65; b = 4.3; c = 9; c' = 13; V = 50.

Descriptions:

Female: Body slender, L-shaped upon fixation, tapering slightly towards anterior region and posteriorly to a filiform tail. Lip region rounded 2-3 um or about 1/6th of midbody width. Stoma small, half lip width. Amphids oval, about 2 um wide, 8-9 um from anterior end of the body. Oesophagus 261-304 um long basal part occupying 16-18% of total oesophageal length. Nerve ring 117-121 um from anterior end of body. Cardia 5-6 um long.

Vulva transverse, vagina 8-9 um long. Female reproductive system mono-prodelphic. Rectum 10-12 um or more than one anal body-width long. Tail long filiform, 120-138 um or 10-13 anal body-widths long.

Type habitat and locality: Soil around roots of an unidentified flowering plant from near Luwangsanbam Air field, Great Imphal, Manipur.

Type specimens: Collected in January 1978. Holotype on slide MNP/Etamphidelus intermedius n.sp./1; paratypes on slide MNP/Etamphidelus intermedius n. sp./2; deposited in the Zoology Department, Aligarh Muslim University, Aligarh.

Differential diagnosis: Etamphidelus intermedius n. sp. comes close to E. japonicus and E. andrássyi n. sp. From E. japonicus it differs in having a longer body, smaller amphids, anteriorly located vulva and longer tail (L = 1.14-1.16 mm; amphids = 3 um wide; V = 65-66; c = 9-10 in E. japonicus).

From E. andrassyi n. sp. it differs in having a wider body and anteriorly located vulva (a = 65-78; V = 68-76 in E. andrassyi).

ETAMPHIDELUS MUCRONATUS N. SP.

(Fig. 7)

Dimensions:

Paratype females (3): L = 1.2-1.8 mm; a = 88-92; b = 3.6-5.4 c = 9-14; c' = 10-15; V = 57-68.

Holotype female: L = 1.3 mm; a = 74; b = 3.9; c = 10; c' = 12; V = 67.

Descriptions:

Female: Body C-shaped upon fixation, tapering anteriorly, posteriorly ending in an elongate-conoid tail. Lip region rounded, almost 1/5th of midbody width. Stoma small, 1-2 um long. Amphids oval, 3-4 um wide, 10-13 um from anterior end. Oesophagus 235-315 um long, basal part 14-24% of total oesophageal length. Nerve ring at 95-120 um from anterior end of body. Cardia discoid, 5-6 um long.

Vulva transverse; vagina 9-15 um long. Female reproductive system mono-prodelphic. Rectum 13-15 um or about one anal body-width long. Tail elongate-conoid, 75-120 um or 10-13 anal body-widths long gradually tapering to a pointed terminus and is provided with a mucro.

Male: Not found

Type habitat and locality: Soil around roots of pineapple, Ananas comosus from Ngariyan Hills, Imphal, Manipur.

Type specimens: Collected in August, 1977. Holotype on slide MNP/Etamphidelus mucronatus n. sp./4; paratypes on slides MNP/Etamphidelus mucronatus n. sp./1-3; deposited in the Zoology Department, Aligarh Muslim University, Aligarh.

Differential diagnosis: Etamphidelus mucronatus n. sp. comes close to E. japonicus, E. puccinellae, E. andrassyi n. sp.,

E. intermedius n. sp. From E. japonicus it differs in having a longer and slender body amphid distance more apart from anterior end, a smaller oesophageal expanded part, a longer tail having mucro. (L = 1.14 - 1.16 mm; a = 54-59; c = 9-10, in E. japonicus). From E. puccinellae it differs in having longer, slender body, well developed labial papillae, smaller amphids and in having mucro on tail (L = 0.8 - 0.95, a = 47.54; amphids = 5 um wide in E. puccinellae). From E. andrassyi n. sp. it differs in having a longer and slender body and a longer tail with mucro (L = 0.9 - 1.2 mm; a = 65-78; c = 7-9 in E. andrassyi n. sp.). It also differs from E. intermedius n. sp. in having a longer and narrower body and a longer tail with mucro (L = 0.9 - 1.0 mm; a = 42-50; c = 8-9 in E. intermedius n. sp.).

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Fig. 1 A - E *Alaimus acutus*

A - Entire female

B - Oesophageal region

C - Anterior end

D - Gonad

E - Tail region

Fig. 1 F - K *Alaimus assamus* n. sp.

F - Entire female

G - Oesophageal region

H - Anterior end

I - Gonad

J - Female tail

K - Male tail

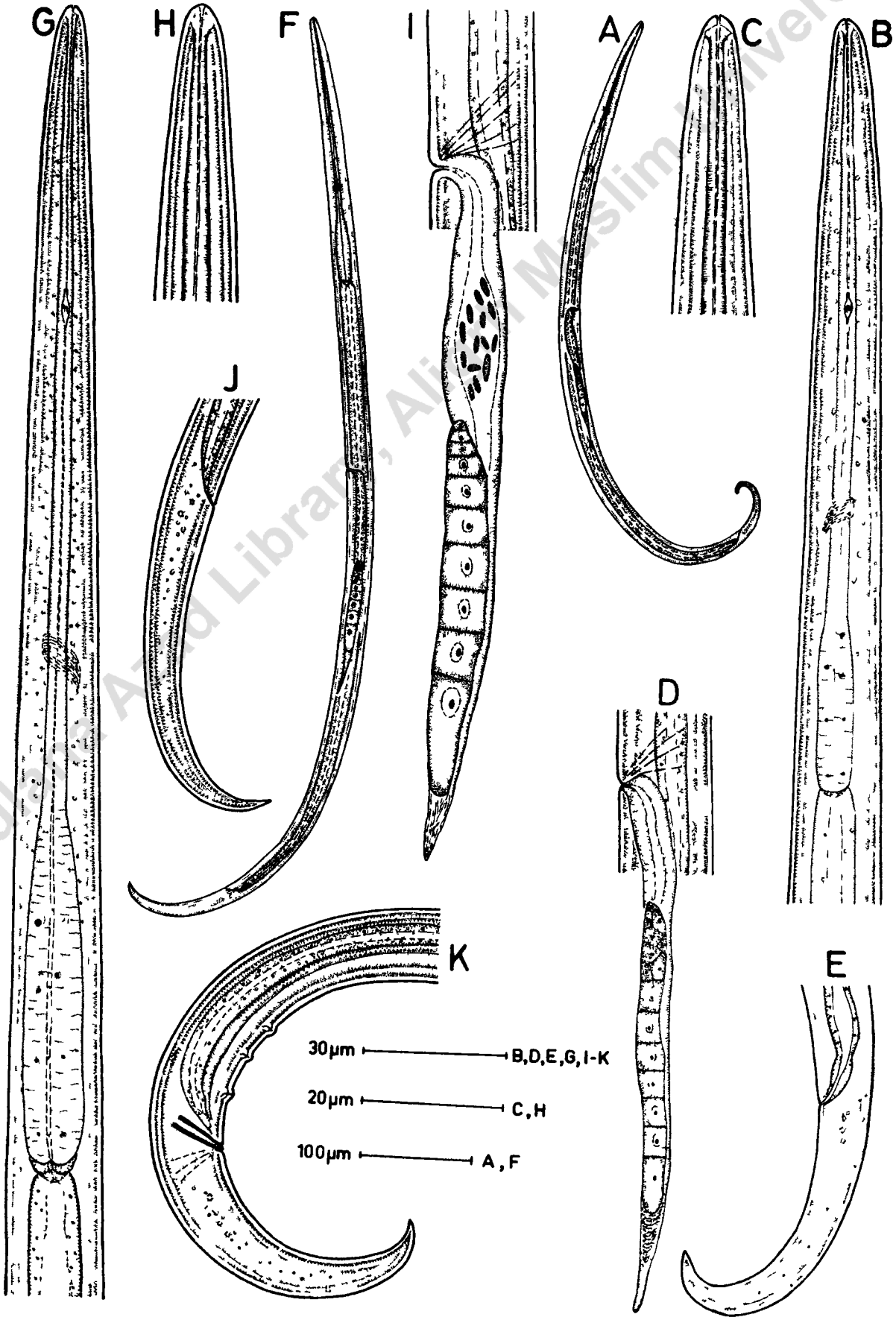


Fig. 2 A - F Alaimus prihamus n. sp.

A - Entire female

B - Oesophageal region

C - Anterior end

D - Gonad

E - Female tail

F - Male tail

Fig. 2 G - K Alaimus historicus n. sp.

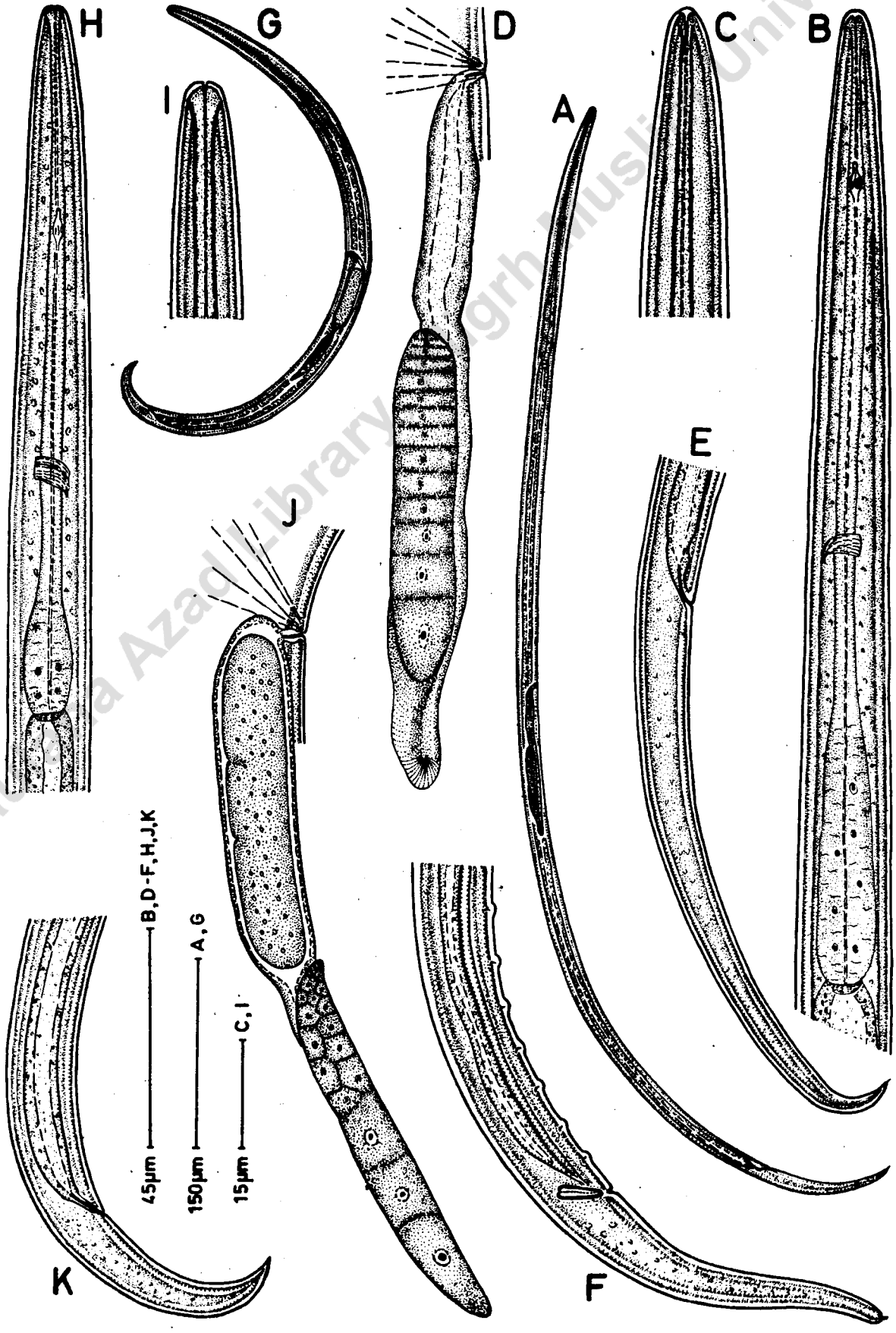
G - Entire female

H - Oesophageal region

I - Anterior end

J - Gonad

K - Female tail


H
G
I
D
C
B
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E
J
B,D-F,H,J,K
A,G
C,I
45µm
150µm
15µm
K
F

Fig. 3 A - F Paramphidelus macer

A - Entire female

B - Anterior end, ventral view

C - Anterior end, lateral view

D - Oesophageal region

E - Gonad

F - Tail region

Fig. 3 G - M Paramphidelus sylvaticus

G - Entire female

H - Anterior end, ventral view

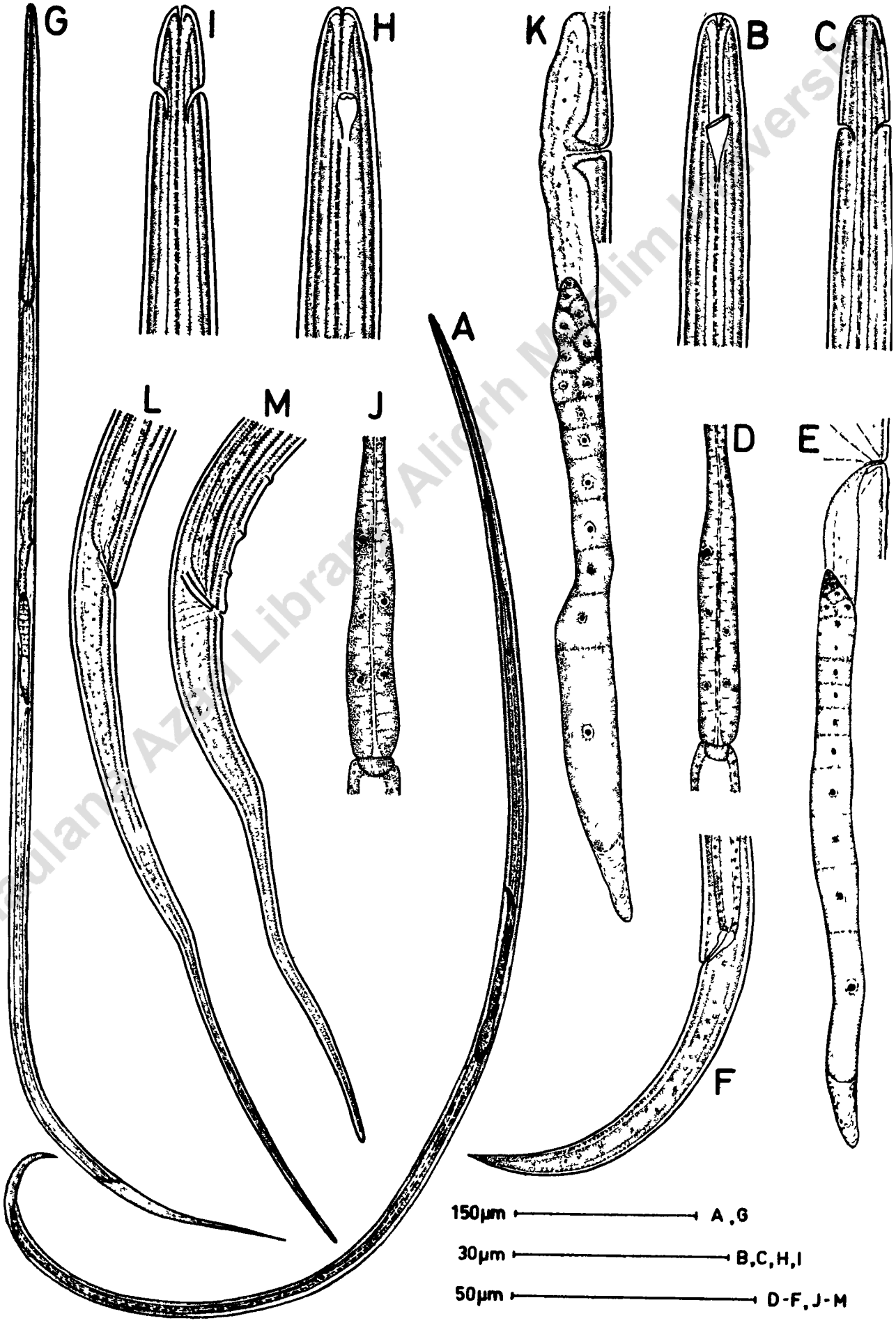
I - Anterior end, lateral view

J - Oesophageal region

K - Gonad

L - Female tail

M - Male tail


G
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150µm
A, G
30µm
B, C, H, I
50µm
D-F, J-M

Fig. 4 **Etamphidelus japonicus**

A - Entire female

B - Anterior end, ventral view

C - Anterior end, lateral view

D - Expanded part of oesophagus

E - Genad

F - Tail region

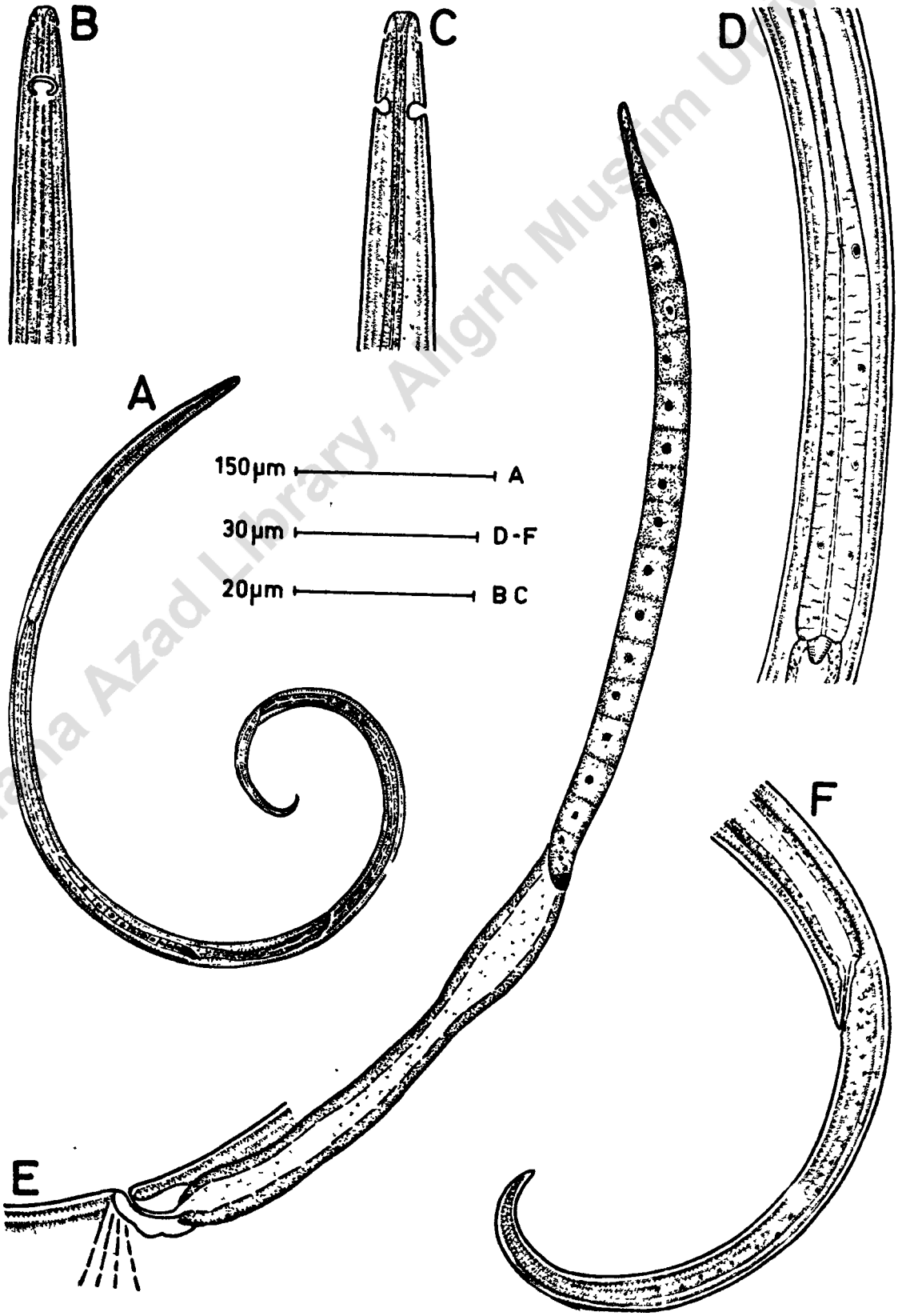

Fig. 5 Ktamphidelus andrassyi n. sp.

A - Entire female

B - Entire male

C - Anterior region

D - Expanded part of oesophagus

E - Gonad

F - Female tail

G - Male tail

Fig. 6 **Stamphidelus intermedius** n. sp.

A - Entire female

B - Anterior end, ventral view

C - Anterior end, lateral view

D - Expanded part of oesophagus

E - Gonad

F - Tail region

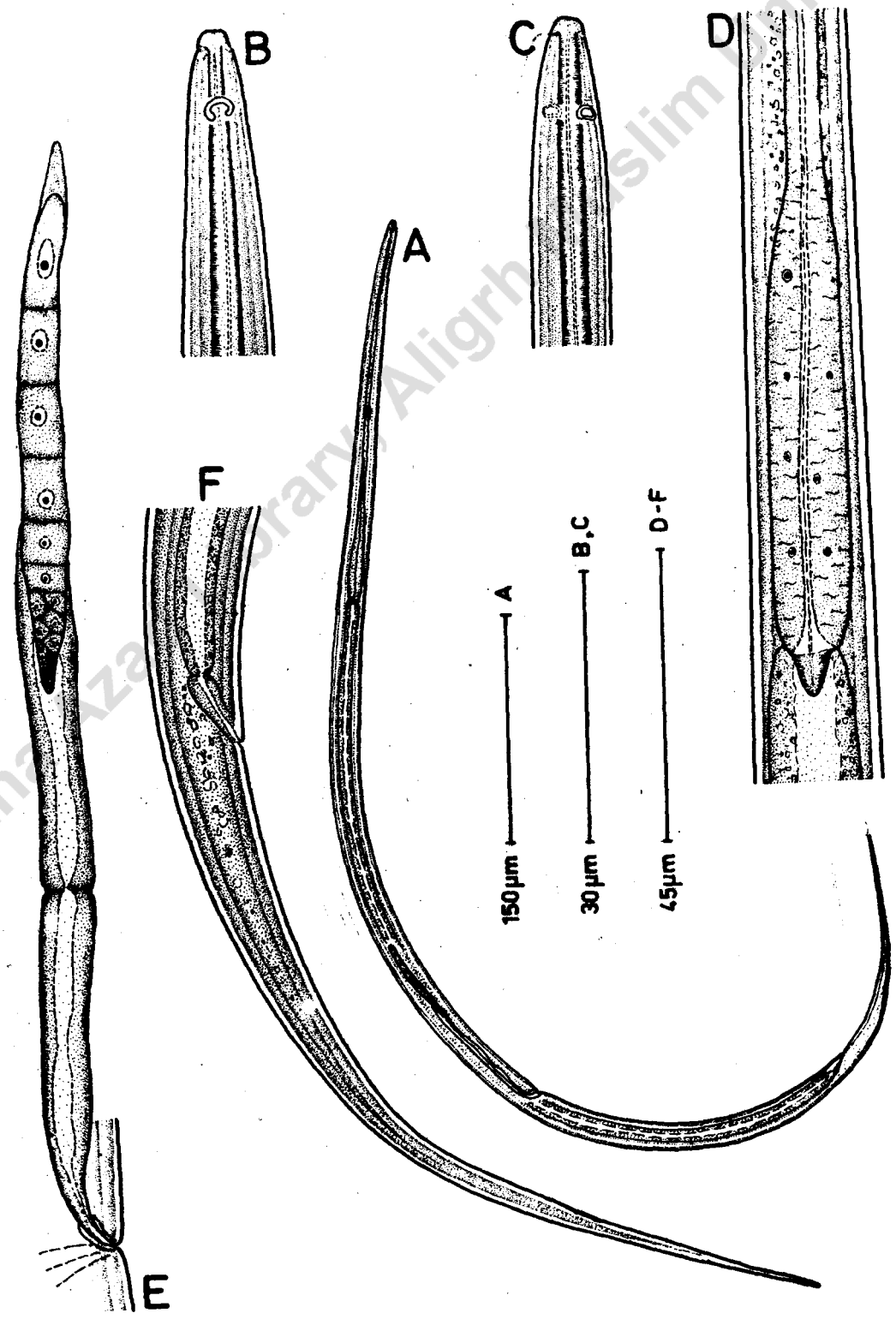

Fig. 7 **Etamphidelus mucronatus** n.sp.

A - Entire female

B - Oesophageal region

C - Anterior end

D - Expanded part of oesophagus

E - Gonad

F - Tail region